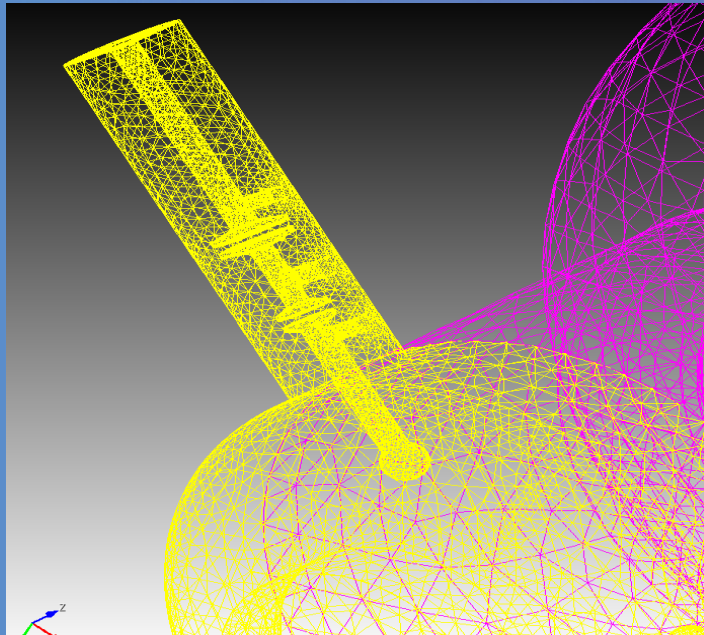


Development of antenna-type HOM couplers at BNL



Sergey Belomestnykh and Wencan Xu
Collider-Accelerator Department, BNL
October 20, 2011

ERL 2011 Workshop
KEK • October 16-21, 2011

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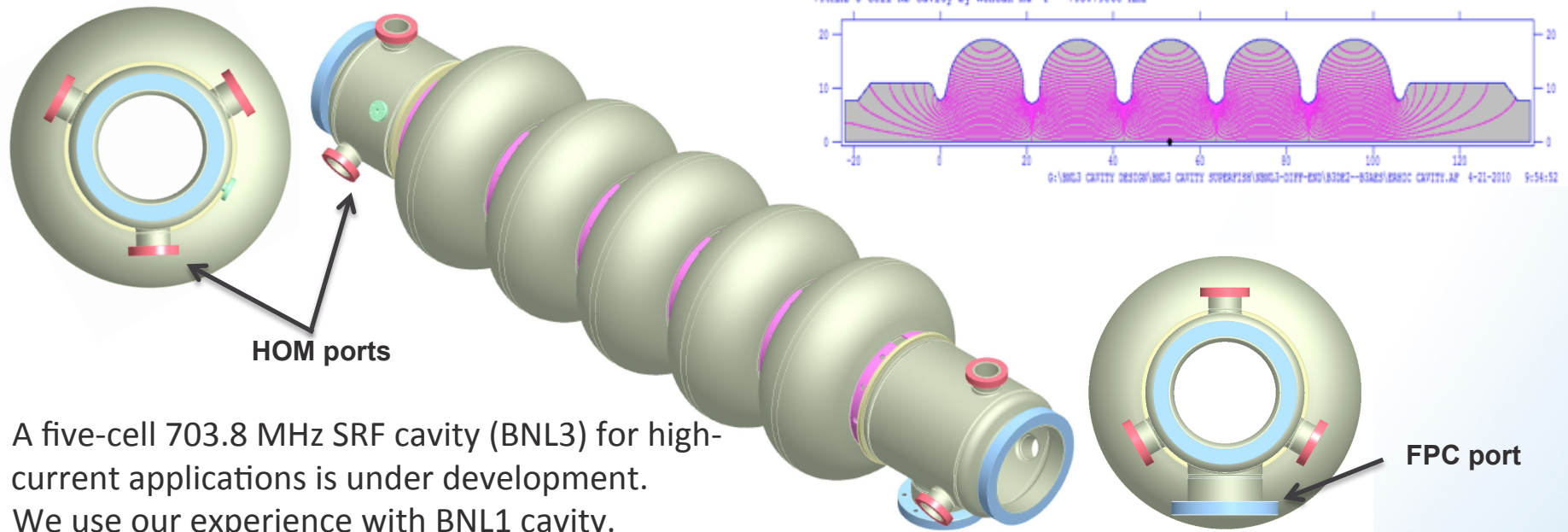
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Acknowledgements

We would like to acknowledge contribution of our colleagues
I. Ben-Zvi, H. Hahn, E. Johnson

Five-cell SRF cavity with strong HOM damping

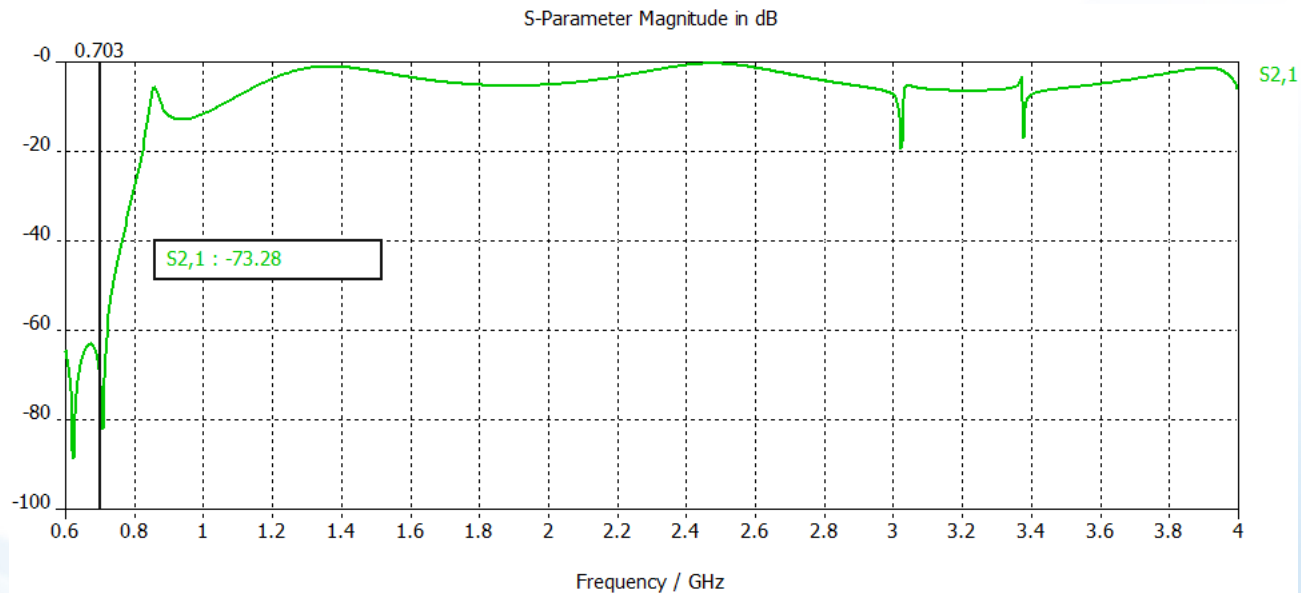
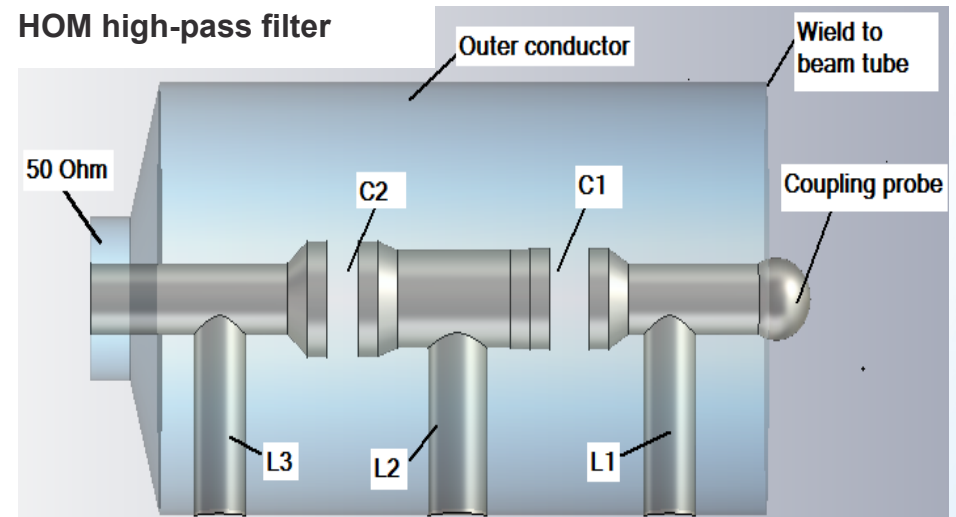


- A five-cell 703.8 MHz SRF cavity (BNL3) for high-current applications is under development.
- We use our experience with BNL1 cavity.
- The cavity is optimized and designed for applications such as eRHIC and SPL.
- Reduced peak surface magnetic field -> reduced cryogenic load.
- Three antenna-type couplers will be attached to a large diameter beam pipes at each end of the cavity and will provide strong HOM damping while maintaining good fill factor for the linac.
- HOM tolerances from BBU simulations.
- The cavities will operate at 19.2 MV/m.

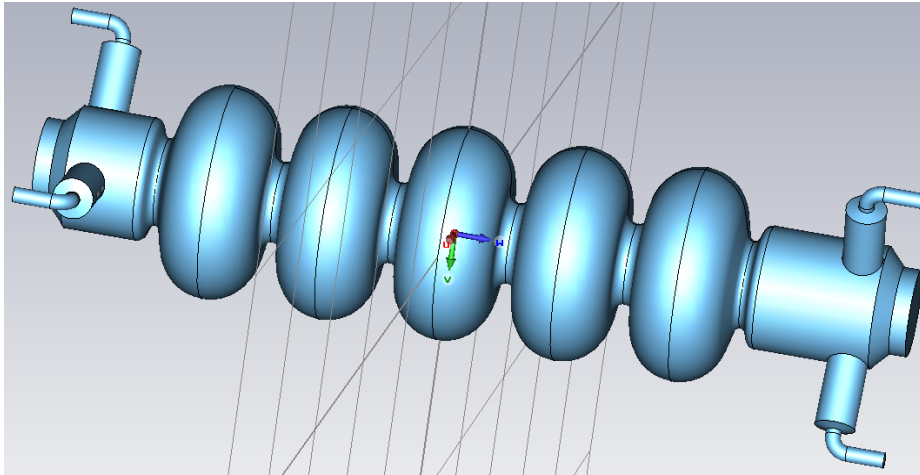
| Parameters | BNL1 | BNL3 |
|----------------------------|-------|-------|
| Frequency [MHz] | 703.5 | 703.8 |
| No. of cells | 5 | 5 |
| Geometry Factor | 225 | 283 |
| R/Q [Ohm] | 404.0 | 506.3 |
| E_{pk}/E_{acc} | 1.97 | 2.46 |
| B_{pk}/E_{acc} [mT/MV/m] | 5.78 | 4.26 |
| Length [cm] | 152 | 158 |
| Beam pipe radius [mm] | 120 | 110 |

HOM damping with antenna-type couplers

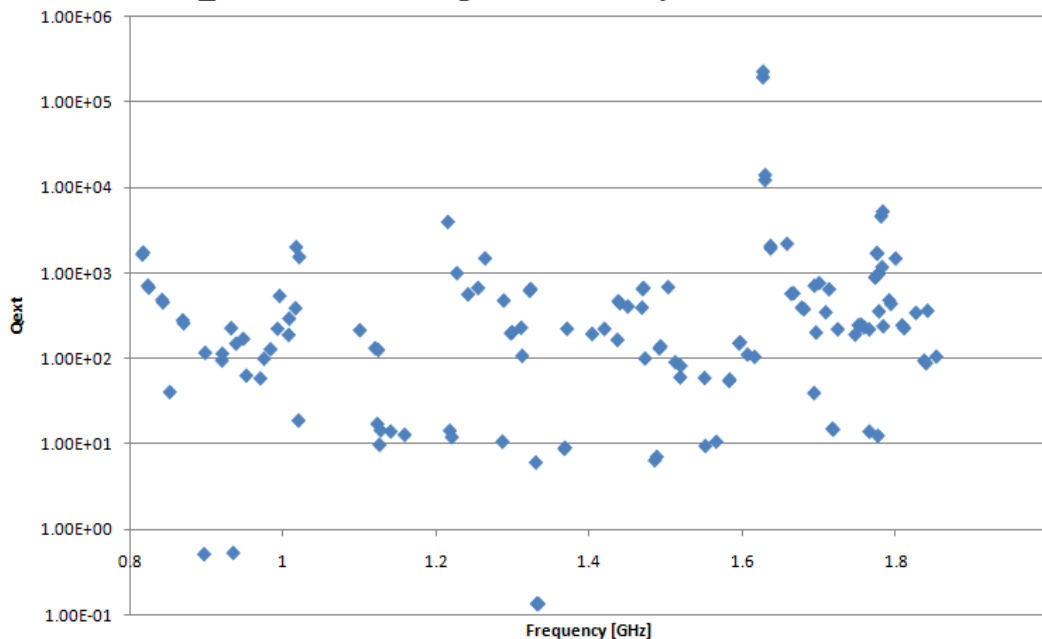
- A two-stage high-pass filter rejects fundamental frequency, but allows propagation of HOMs toward an RF load.
- 1st HOM is at 0.82 GHz.



HOM damping

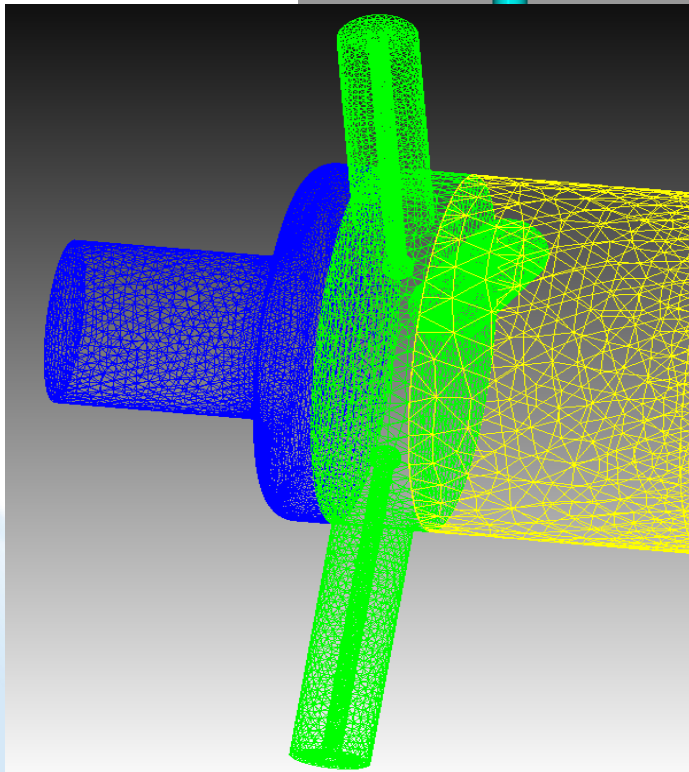
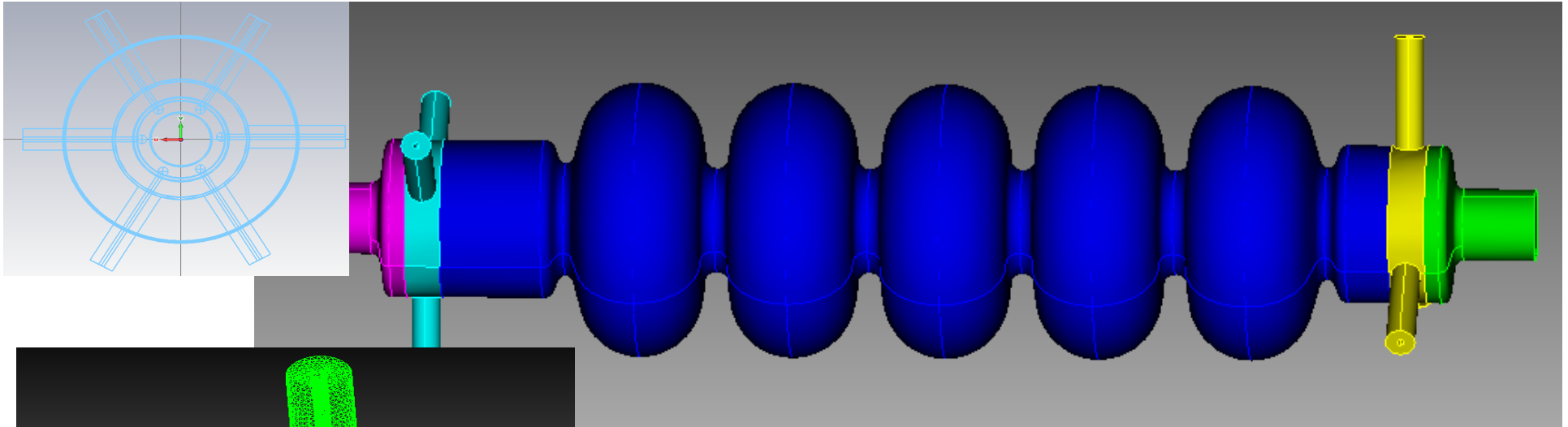


Q_{ext} with 2 120 degree HOM couplers at each side



- Total HOM power to extract is 7.3 kW per cavity (loss factor 3.5 V/pC).
- Simulated a model with two HOM couplers per side using CST MWS.
- Modes at 1.62 GHz have R/Q of ~ 0.1 Ohm.
- Q_{ext} required from BBU simulations for dipole modes is $\sim 40,000$.

Optimization of the cavity with 3 couplers



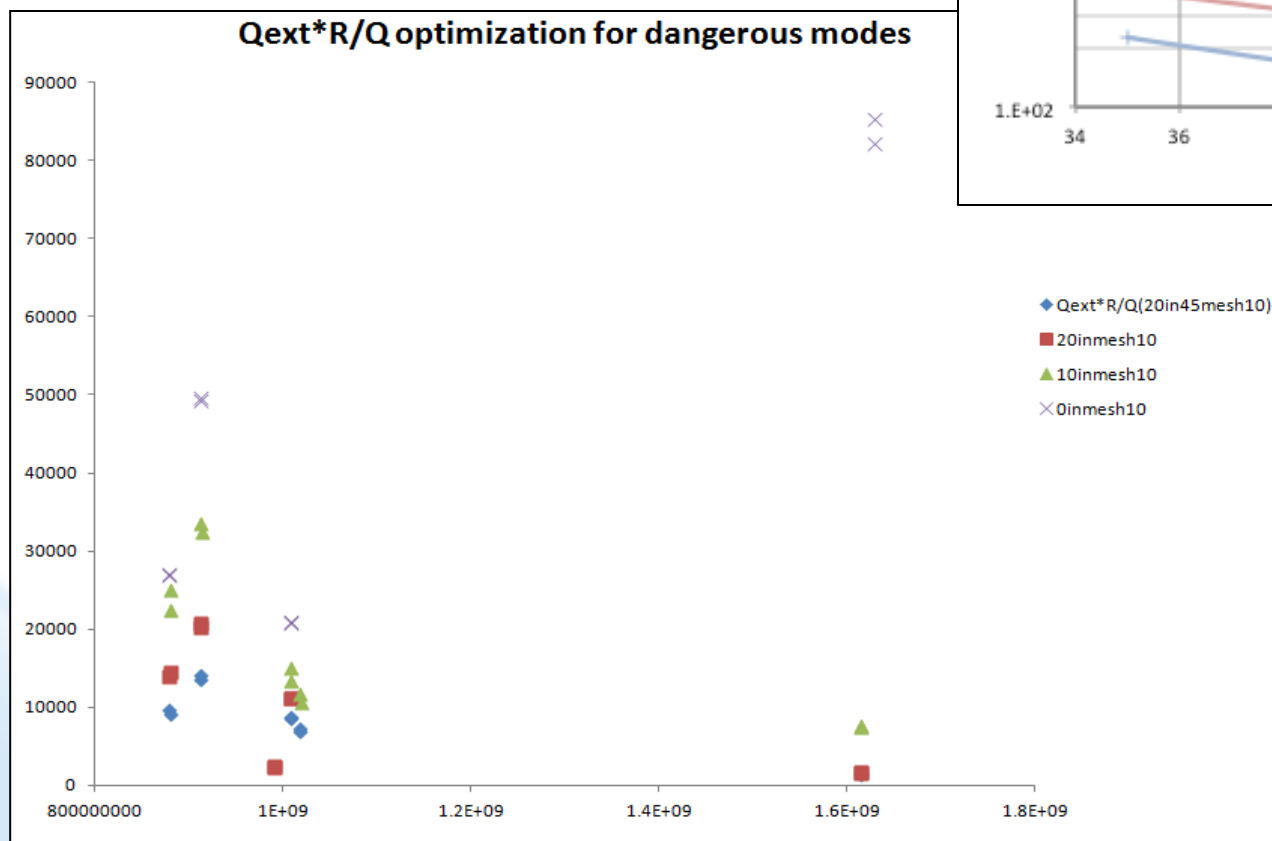
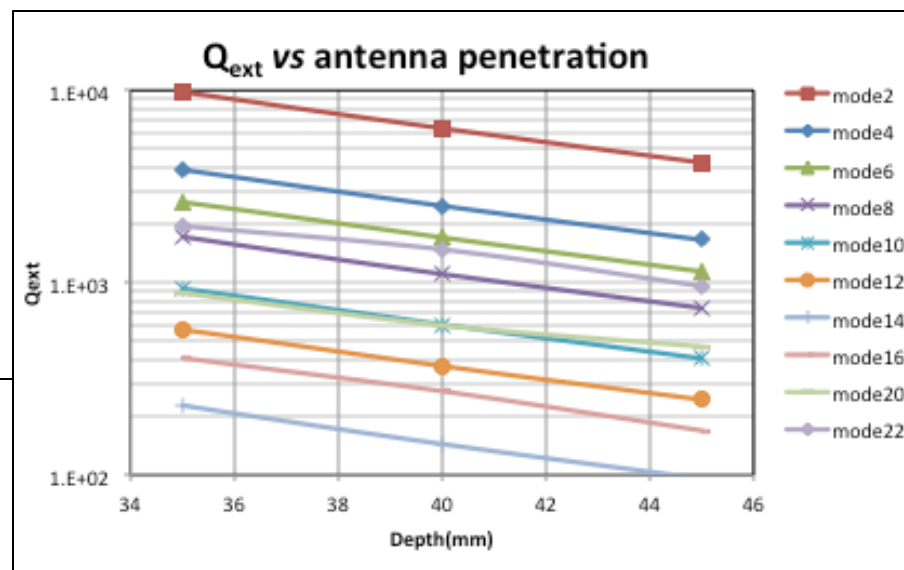
Optimization using Omega3P:

- Longitudinal position of the HOM coupler.
- Length of the antenna.
- Ball radius at the end of antenna.

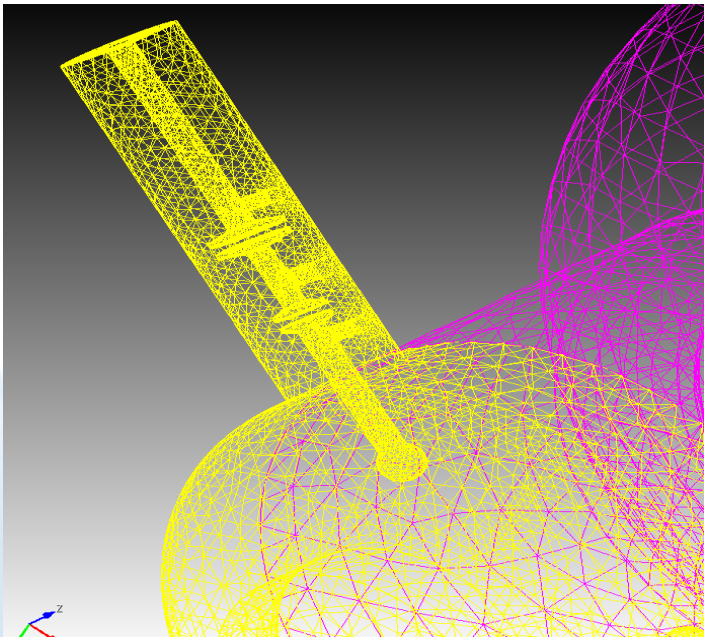
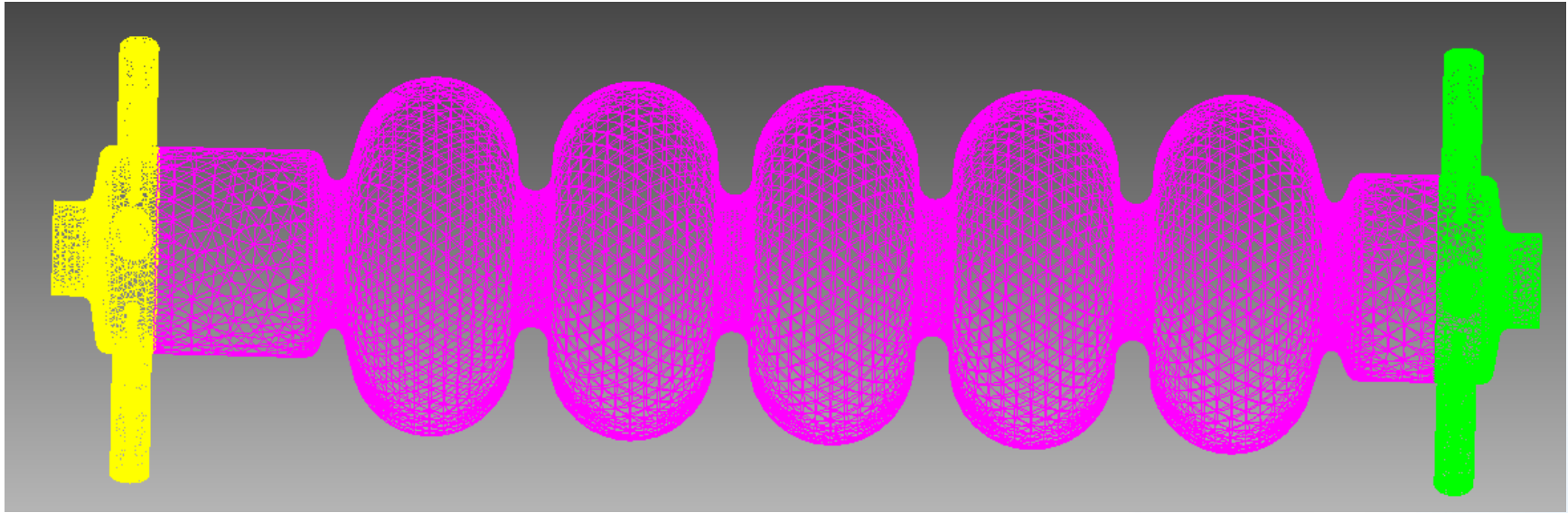
First step: no filter.

Preliminary simulation results

- For 5 GeV eRHIC ERL with 48 cavities the BBU threshold is 156 mA for 0.1% rms HOM frequency spread.
- The threshold increases to 206 mA for 0.5% frequency spread.
- This is still work in progress, the linac optics is not optimal yet.



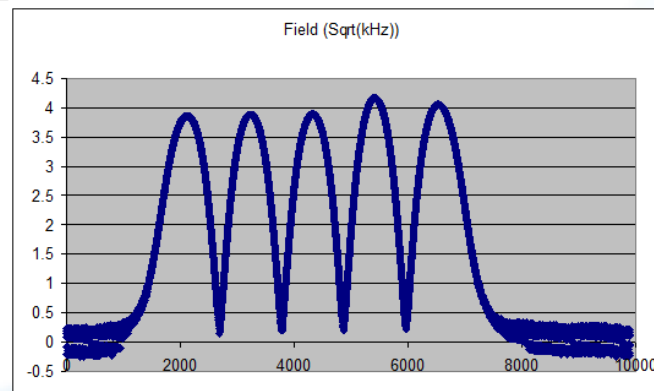
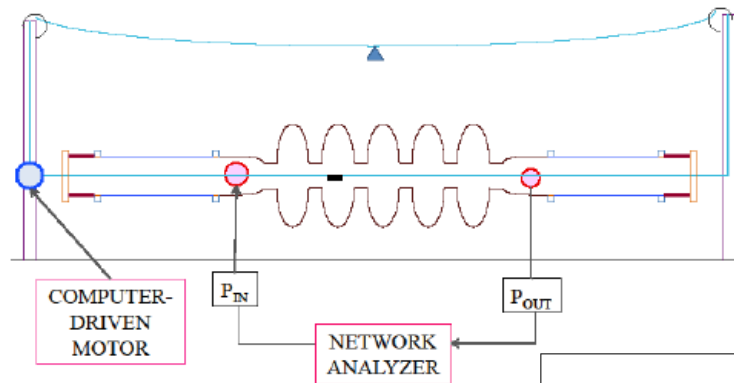
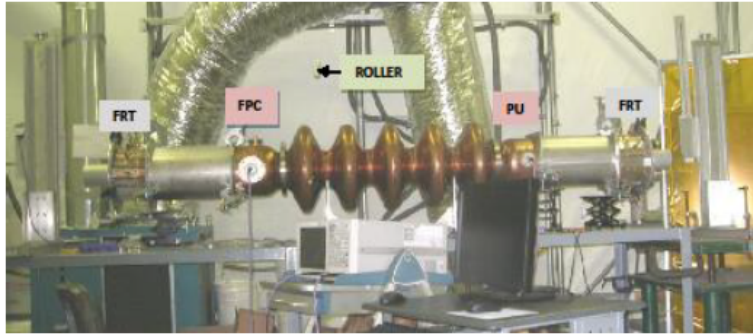
Next steps



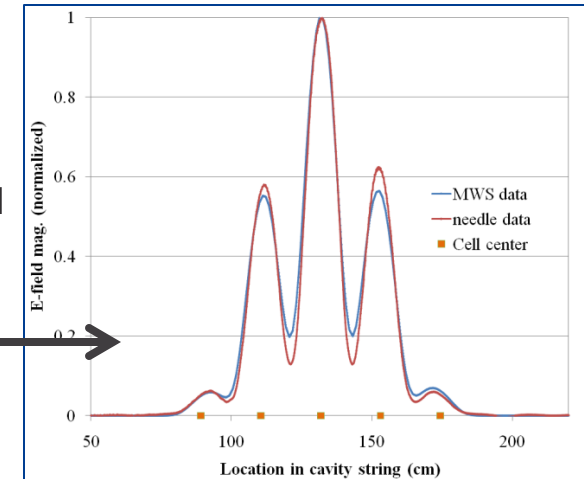
- Add FPC – should fix mode polarization.
- Finalize antenna length/position.
- Add high-pass filter.
- Simulate a string of cavities.
- Compare results with measurements on the BNL3 copper model.



HOM identification with bead pulling

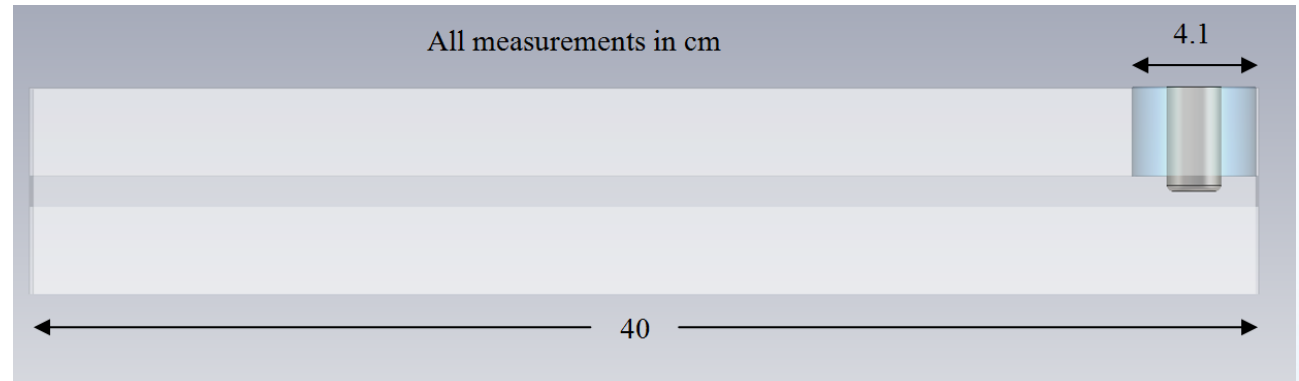
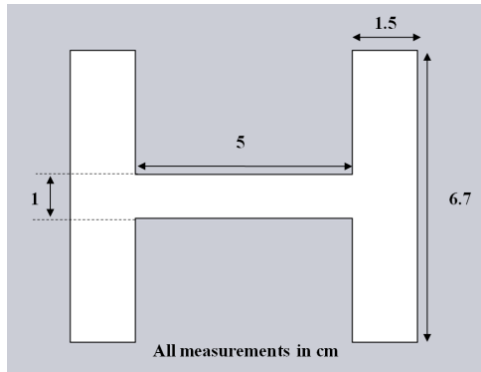


- A method of HOM identification using a bead pull system was developed.
- BNL1 cavity copper model was used for initial measurements.
- Both a metallic needle and a dielectric sphere were calibrated.
- 959 MHz dipole HOM
- BNL3 copper model field flatness right after fabrication: the fields are 93%,93%,93%,100%,97%

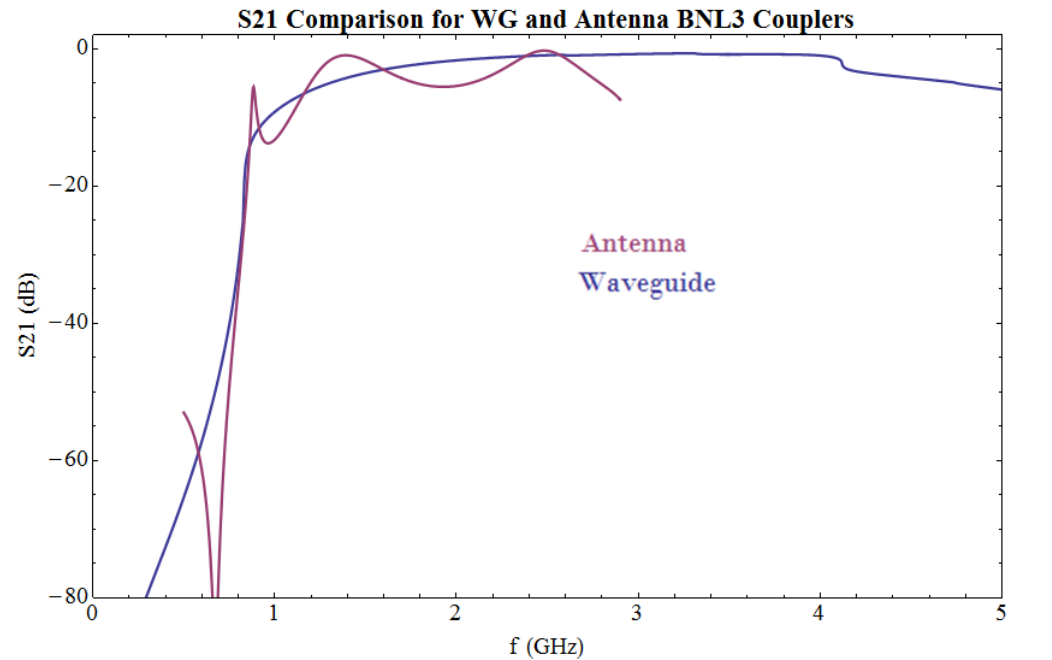


BNL3 cavity ready to be tuned at AES

Alternative coupler scheme



- Waveguide as a high-pass filter.
- Ridge WG for compactness.



Summary

- Antenna-type HOM coupler are being developed at BNL for future ERLs of eRHIC.
- The couplers use high pass filters to prevent unwanted loading of the fundamental mode.
- Two designs are under considerations: one employing coaxial-line-based filter and one employing a waveguide filter.
- Computer simulations with CST MWS and Omega3P are in progress.
- They will be compared with measurements of a BNL3 copper model.